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METHODS OF CHOOSING A RATIONAL VARIANT OF THE PROTECTION ON THE BASIS OF EXPERT INFORMATION

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Considered the principal features of choosing a rational variant of security system in a high degree of uncertainty in the environment of its functioning. On the basis of these features are presented methods for solving multicriteria problems with expert source of information: the method of the main index, the method of the resulting figure, lexicographical method.

Keywords: security system, expert information, multicriteriality choice problem, fuzzy sets, lexicographical methods, main index, result indicator.

Abstract

Parameter estimates of security system under conditions of high uncertainty of its operation should not be calculated by using one mathematical model, but by coherent family of models. However, the lack of a sufficiently general theory that forms the methodological basis of the study of phenomena with uncertain factors does not apply Bayesian methods of classical statistical decision theory for the design of optimal systems of protection.

The complexity of decision-making, lack of mathematical formalism leads to the fact that evaluating and selecting alternative protection you need to use and process quality expert information. A promising direction of development of methods of decision-making under expert source of information is the linguistic approach based on the theory of fuzzy sets and linguistic variables.

Security system option

The principal feature of choosing a rational variant of security system, determine the method of its solution are:

— multicriteriality choice problem;

— not only quantitative but also qualitative (fuzzy) description of quality indicators security system, as defined requirements;

— with fuzzy formulation of the problem influence the choice of the method of its solution expert information that determines the preference of an indicator.

The general formulation of multi-criteria optimization problem is as follows.

Set $\bar{X} = |x_1, \dots, x_i, \dots x_n|$ – vector optimized parameters of a system of S. For a j-th feature of the system is characterized by S j-th indicator $q_j(\bar{X}); j = \overline{1,m}$. Then the system as a whole is characterized by a vector of indices $\bar{Q} = |q_1, \dots, q_j, \dots q_m|$. Multi-criteria optimization task is to ensure that the set S of variants of M_s choose this option (system S_0), which has the best value of the vector $\bar{Q}$. It is assumed that the concept of "best vector $\bar{Q}$" pre-formulated mathematically, that is selected (grounded) corresponding criterion of preference (preference relation).

Analysis of the literature [1] shows that all the many methods for solving multicriteria problems can be reduced to three groups of methods:

- The method of main index;
- The method result indicator;
- lexicographical methods (methods of successive assignments).

Let us briefly consider the essence of these methods for solving multicriteria problems.

The method of main index

Based on the transfer of all quality indicators, in addition to any uniform, called the main, in the category of restrictions such as equalities and inequalities. [2] Assign the main index number$q_1(S)$. Then the task is reduced to a one-criterion problem of the choice of $S \in M_s$, having a minimum value of the index $q_1(S)$ with constraints of equality and inequality, so it has the form $\min\limits_{S \in M_s} q_1(S)$ with restrictions

$$q_j(S) = q_{j0};\ j = 2, \dots, l;$$
$$q_k(S) \le q_{k0};\ k = l+1, \dots, p;$$
$$q_r(S) \ge q_{r0};\ r = p+1, \dots, m.$$

Method main indicator has the following disadvantages:

1. In most cases, there are insufficient grounds to assume any one, and, moreover, a definite indicator of quality is the primary, and all others – secondary.

2. For quality indicators $q_2(S), \dots, q_m(S)$, translated into the category of restrictions, it is difficult to establish their allowable values.

The method of the resulting quality score

The method based on the formation of a generalized index by intuitive assessments of the impact of private quality indicators $q_1, \dots, q_m$ on the resulting quality of its system functions. Estimates of such influence are a group of specialists - experts with experience in the development of such systems. [3]

The most widely used among the resulting quality indicators received the additive, multiplicative and minimax performance.

Additive quality score is the sum of the weighted normalized partial indicators and looks

$$Q = \sum_{j=1}^{m} \omega_j \bar{q}_j\,, \qquad (5.1)$$

where $\bar{q}_j$ – is normalized value j-th indicator;

ω_j – weighting factor j-th index, which has the larger value, the more it affects the quality of the system; $\sum_{j=1}^{m} \omega_j = 1;\ \omega_j > 0; j = \overline{1,m}$

The main disadvantage of the additive indicator is that its benefits may be mutual compensation of particular indicators. This means that a reduction of performance down to zero can be offset an increase of another indicator. In order to mitigate this disadvantage are special restrictions on the minimum values of particular indices, their weight, as well as using other methods. [3]

Multiplicative quality index is formed by multiplying the partial indicators, taking into account their weights and has the form

$$Q = \prod_{j=1}^{m} \overline{q_j^{\omega_j}}\,, \qquad (5.2)$$

The most significant difference multiplicative index of the additive is an additive that figure is based on the principle of the absolute fair concessions on individual indicators, and multiplicative – on the principle of a fair relative concessions. The latter is rightly considered that such a compromise

when the total level of the relative decline of one or several indicators does not exceed the total level of the relative increase in other indicators.

Maximin indicator. In some cases, the resulting form of the objective function is rather difficult to justify or apply. In such cases the possibility of a simple way to solve the problem is to use maximin indicator. Rule select the optimum system S_0 in this case is as follows

$$\max_{S\in M_S} \min_{1\le j\le m} \{\overline{q_1}(S), \dots, \overline{q_1}(S), \dots, \overline{q_1}(S)\} \quad (5.3)$$

if the weights of particular indicators are not available;

$$\max_{S\in M_S} \min_{1\le j\le m} \{\overline{q_1}^{\omega_1}(S), \dots, \overline{q_J}^{\omega_j}(S), \dots, \overline{q_m}^{\omega_m}(S)\} \quad (5.4)$$

if the weighting coefficients are determined.

Maximin indicator provides the best (highest) value of the worst (smallest) of particular indicators of quality.

Lexicographic method. Suppose that the indicators in order of importance, such as $q_1(S) > q_2(S) > \dots > q_m(S)$.

The method consists in the allocation of first set of alternatives with the best estimate of the most important indicators. If this is the only alternative, it is considered the best; if there are several, some of them stand out a subset of those that have a better estimate for the second parameter, etc.

To expand the set of alternatives considered, and improve the quality of decisions on the set of indicators can be assigned to a concession within which alternatives are considered equivalent. [3]

Conclusion

The principal feature of the problem of choosing the rational option security system is predominantly qualitative indicators treated as the requirements asked for security system. In this regard, considered methods of multi-criteria optimization should be formulated in a fuzzy statement. In this case, indicators of quality are something else as a function of accessory options security system given level of quality.

As in the classic and in the formulation of the choice of method of fuzzy multicriteria decision is determined by the form in which the information is presented expert preference values or their importance. Therefore, in concluding this section, we present a table that can reasonably choose the method of fuzzy multi-criteria optimization based on expert information on the preference parameters.

Table 5.1. The choice of method of fuzzy multi-criteria optimization based on expert information

Expert information	method of solving multicriteria
No information	Maximin method (5.3)
Indicators are ordered by importance	Lexicographic method
Determined the weights of indicators	1. Additive index (5.1) 2. Multiplication rate (5.2) 3. Maximin indicator (5.4)

Методы выбора рационального варианта защиты на основе экспертной информации

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Аннотация

Рассмотрены принципиальные особенности решения задачи выбора рационального варианта защиты ИС в условиях высокой степени неопределенности условий ее функционирования. На основе этих особенностей представлены методы решения многокритериальных задач при экспертной исходной информации: метод главного показателя, метод результирующего показателя, лексикографические метод.

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